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Draft Report

Midway Landfill Remedial Investigation Receptors Investigation and Preliminary Endangerment Assessment

Seattle Engineering Department
Solid Waste Utility

January 1988

DRAFT

MIDWAY LANDFILL
REMEDIAL INVESTIGATION

RECEPTORS INVESTIGATION
AND
PRELIMINARY ENDANGERMENT ASSESSMENT

Prepared for:

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January 1988

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1.0 OVERVIEW OF THE SUPERFUND PUBLIC HEALTH EVALUATION PROCESS

The Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA; commonly referred to as "Superfund"), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), together establish a national program for responding to releases of hazardous substances into the environment. In addition, the National Oil and Hazardous Substances Pollution Contingency Plan ("National Contingency Plan", or NCP) establishes the process for determining appropriate remedial actions at Superfund sites. CERCLA, SARA, and the NCP together require that a remedial action selected for a Superfund site be cost-effective and that it be adequate to protect public health. The NCP, Guidance on Remedial Investigations Under CERCLA (USEPA 1985a), and Guidance on Feasibility Studies Under CERCLA (USEPA 1985b) require that selection of a cost-effective remedy be based on a comparison of alternatives that examine public health impacts, environmental impacts, technological and engineering feasibility, cost, and institutional factors.

Section 104 of CERCLA authorizes remedial actions to protect public health, welfare, or the environment when there is a release or substantial threat of release of any hazardous substance or when there is a release or substantial threat of release of any pollutant or contaminant that may present an imminent and substantial danger to the public health or welfare.

The Midway Landfill Remedial Investigation provides information used to determine the probability of "release or substantial threat of release" of hazardous substances, pollutants, or contaminants, as these are defined by CERCLA and SARA. The Midway Landfill Remedial Investigation was conducted in accordance with the following guidelines:

- USEPA (1985a). Guidance on Remedial Investigations Under CERCLA. Prepared for Hazardous Waste Engineering Research Laboratory, Office of Research and Development, and Office of Emergency and Remedial Response, and Office of Waste Programs Enforcement, Office

of Solid Waste and Emergency Response, US Environmental Protection Agency, Washington, D.C.

- USEPA (1985b). Guidance on Feasibility Studies Under CERCLA. Prepared for Hazardous Waste Engineering Research Laboratory, Office of Research and Development, and Office of Emergency and Remedial Response, and Office of Waste Programs Enforcement, Office of Solid Waste and Emergency Response, US Environmental Protection Agency, Washington, D.C.

- Black & Veatch (1986a). Final Project Work Plan for Remedial Investigation, Midway Landfill, Kent, Washington. Prepared for the Washington Department of Ecology, July 1986.

- Black & Veatch (1986b). Final Remedial Investigation Sampling and Analysis Plan for Midway Landfill, Kent, Washington. Prepared for the Washington Department of Ecology, July 1986.

- Parametrix, Inc. (1986). Midway Landfill Remedial Investigation Scope of Work. Prepared for the City of Seattle, Solid Waste Utility, July 23, 1986.

- Parametrix, Inc. (1986). Quality Assurance Project Plan for the Midway Landfill Remedial Investigation. Prepared for the City of Seattle, Seattle Engineering Department, Solid Waste Utility, December 1986.

The Receptors Investigation and the Preliminary Endangerment Assessment provide the information on public health impacts required as part of the Midway Landfill Remedial Investigation. The information contained in the Midway Landfill RI, including this report, forms the foundation for the final Endangerment Assessment required as part of the Midway Landfill Feasibility

Study (FS). The Feasibility Study is the next step in the process of determining the appropriate remedial actions, if any, required to protect the public health, welfare, and the environment in the vicinity of the Midway Landfill.

2.0 RECEPTORS INVESTIGATION

2.1 INTRODUCTION

The primary purpose of any Remedial Investigation (RI) required under CERCLA is to identify potential pathways of contaminant migration away from the waste site, define the rate and extent of contaminant migration via each of the identified pathways, and, given these potential pathways, to identify potential or actual receptors who may be exposed to hazards attributable to the site.

For the purposes of this report, "potential receptors" are defined as human or environmental populations in the vicinity of the Midway Landfill, which, originating from the L.F. if the landfill were a source of contaminants migrating off-site, would be potentially at risk of exposure to these contaminants. In the following discussion, it should be remembered that the term "potential receptors," as used, does not imply that exposures are actually occurring.

The Preliminary Endangerment Assessment is included as the next section of this document, and is required as part of the Midway Landfill Remedial Investigation. The purpose of the Preliminary Endangerment Assessment is to outline the findings of the various RI Technical Reports required to evaluate whether hazardous substances, pollutants, or contaminants attributable to the Midway Landfill have migrated offsite. The Preliminary Endangerment Assessment serves to highlight those conditions which should be evaluated in greater detail in the Endangerment Assessment required as part of the Midway Landfill Feasibility Study (FS). The purpose of the Endangerment Assessment required under the FS is to evaluate the magnitude and probability of human or environmental exposures to hazardous substances, pollutants, or contaminants identified during the Remedial Investigation, and to provide estimates of the actual and potential impacts to public health, welfare and the environment.

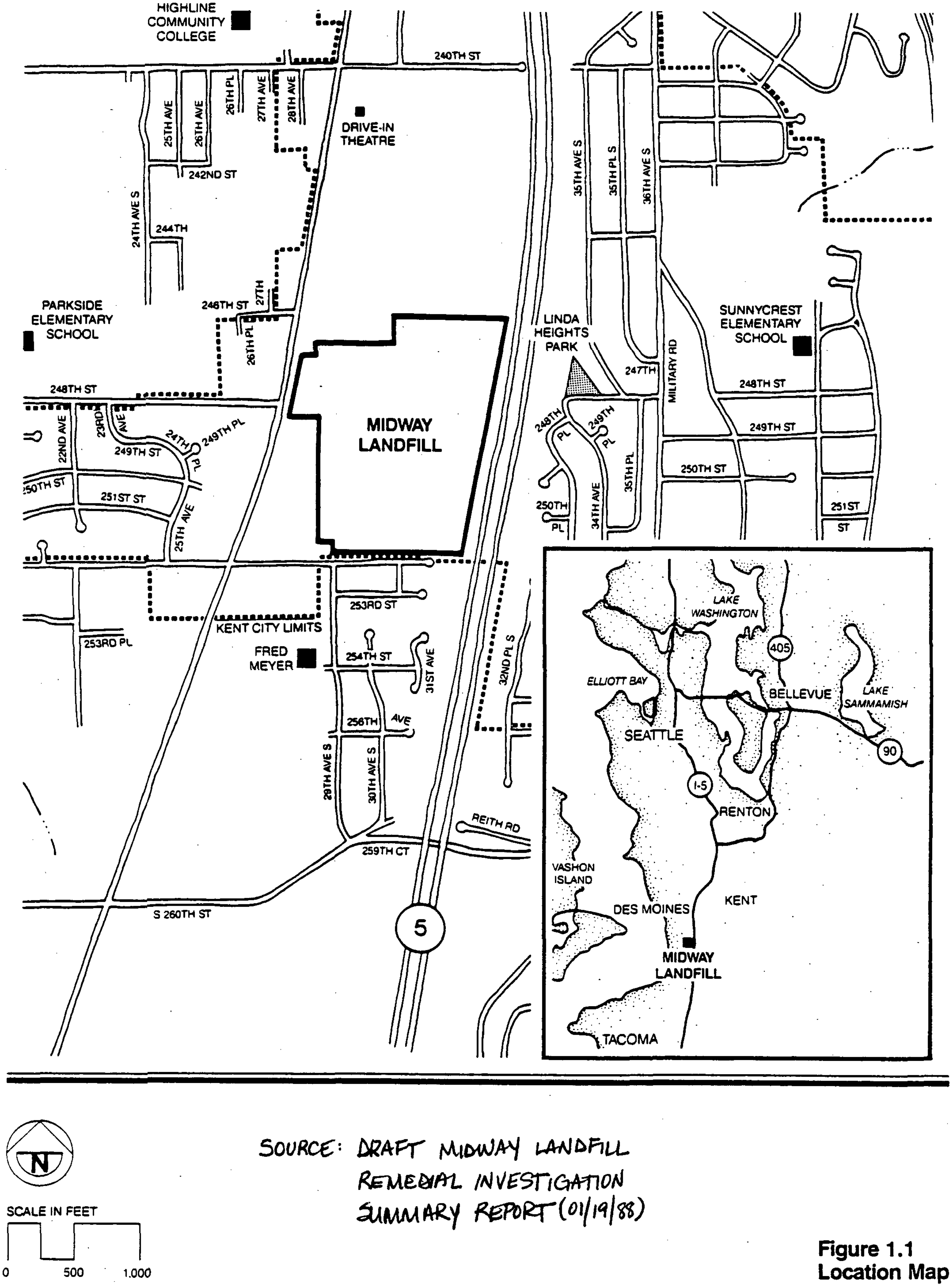
A general location map of the Midway Landfill vicinity is given in Figure 1.1 (Source: Draft Midway Landfill Remedial Investigation Summary Report; draft dated 1/19/88).

2.2 POTENTIAL CONTAMINANT MIGRATION PATHWAYS INVESTIGATED DURING MIDWAY LANDFILL REMEDIAL INVESTIGATION

Potential migration pathways investigated as part of the Midway Landfill Remedial Investigation included:

- Ambient air (described in the Midway Landfill Remedial Investigation Air Quality Technical Report)
- Surface water runoff (described in the Midway Landfill Remedial Investigation Surface Water Technical Report)
- Surface soils (described in the Midway Landfill Remedial Investigation Seeps and Soils Technical Memorandum)
- Seeps (described in the Midway Landfill Remedial Investigation Seeps and Soils Technical Memorandum)
- Subsurface gas-bearing strata or man-made conduits (described in the Midway Landfill Remedial Investigation Landfill Gas Technical Report)
- Subsurface water-bearing strata (described in the Midway Landfill Remedial Investigation Groundwater Technical Report)

The pathways investigated during the Midway Landfill RI were those specified in the Midway Landfill RI Work Plan (Black & Veatch, 1986a) and the Midway



SOURCE: DRAFT MIDWAY LANDFILL REMEDIAL INVESTIGATION SUMMARY REPORT (01/19/88)

Figure 1.1
Location Map

Landfill RI Sampling and Analysis Plan (Black & Veatch, 1986b), as directed by the Washington Department of Ecology.

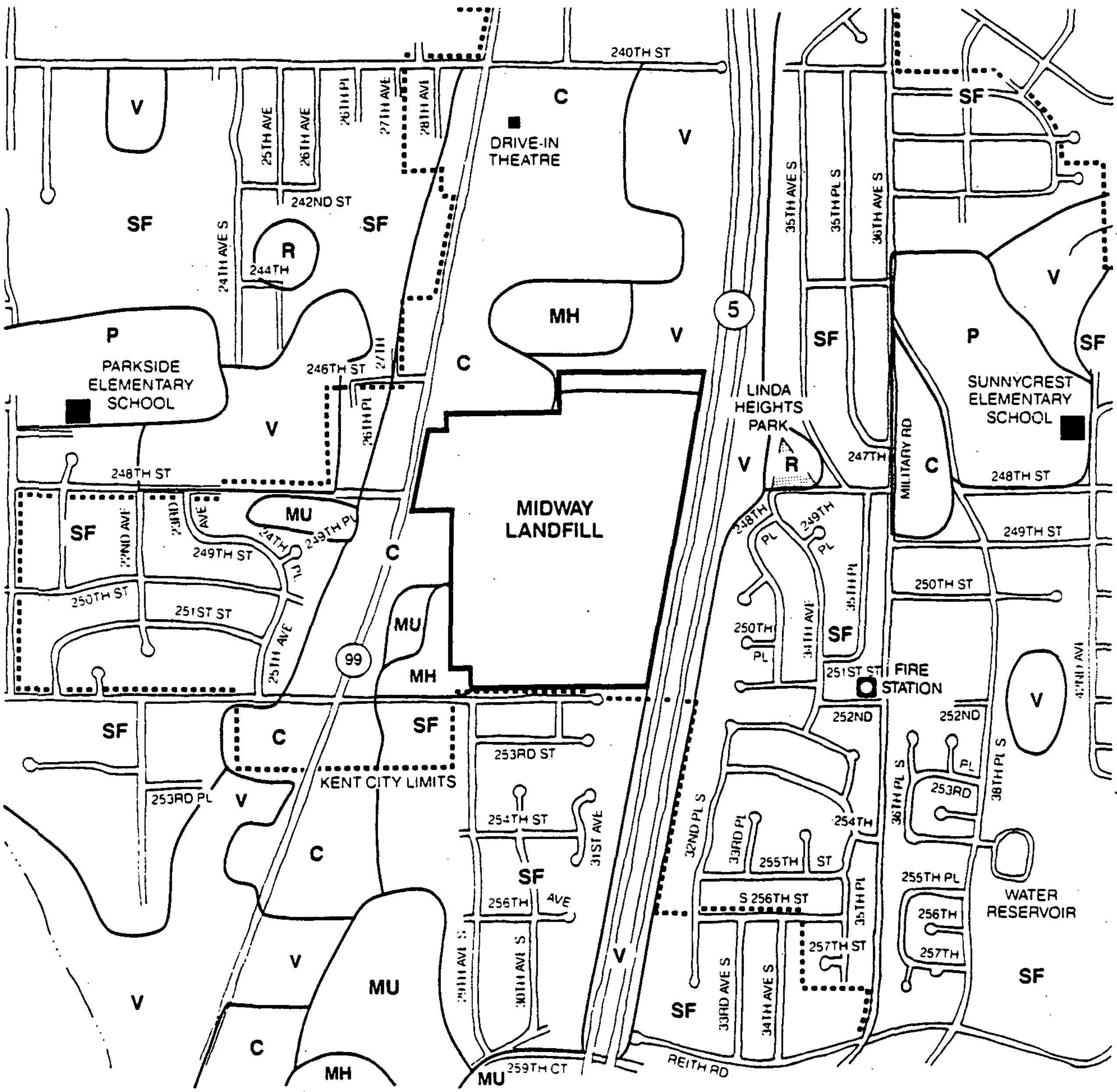
2.3 HUMAN POPULATIONS

Detailed review of potential human receptors in the vicinity of the Midway Landfill has not been completed. Information to be included in the final Receptors Investigation will describe:

- o Total human population in vicinity of Midway Landfill
- o Population density
- o Population movement patterns
- o Exposure potential
- o Future growth and development trends

Generalized land use in the vicinity of the Midway Landfill is shown in Figure 2.1 (Source: Draft Midway Landfill Remedial Investigation Summary Report (01/19/88). This figure shows the locations of residential, commercial, public, park and recreational, and vacant areas in the vicinity of the Midway Landfill at that time. Potential human receptors identified in the vicinity of the Midway Landfill include the following:

- o Human populations residing in the landfill vicinity, e.g.,
  - Census tract 290, to the west of Interstate 5 and including the Midway Landfill (total population = ________).
  - Census tract 291, to the east of the Midway Landfill (total population = ________)



SF	Single Family Residential
MU	Multi-Unit Residential
MH	Mobile Home Residential
C	Commercial
P	Public
R	Parks and Recreation
V	Vacant

N

SCALE IN FEET

0 1,000 2,000

SOURCE: DRAFT MIDWAY LANDFILL REMEDIAL INVESTIGATION SUMMARY REPORT (01/19/88)

Figure 2.1
Generalized Land Use in Midway Landfill Vicinity

- Human users of drinking water wells (refer to the following):

  - Table 4.1 (Source: Technical Memorandum for the Midway Landfill Remedial Investigation, Water Well Inventory (Technical task 2.2.6; dated January 1988), lists the location and owners of public and private water wells in the vicinity of the Midway Landfill, including notations regarding present use (e.g., private, domestic, unused, unknown) and present condition (e.g., operating, capped, covered operable, unknown).

  - Figure 2.2 (Source: Draft Midway Landfill Remedial Investigation Summary Report (01/19/88) shows private and public water wells located within a one-mile radius of the Midway Landfill, including wells presently being used for human drinking water supplies and wells not currently in use for human drinking water supplies.

  - Figure 2.3 (Source: Draft Midway Landfill Remedial Investigation Summary Report; draft dated 1/19/88) shows the location of public water supply wells within a radius of approximately 5 miles from the Midway Landfill.

- Human populations utilizing businesses in the landfill vicinity (see Figure 2.1), e.g., including:

  - Fred Meyer shopping center to the south of the landfill

Table 4.1 Public and private wells in the vicinity of the Midway Landfill site

Well #	Owner/Property Address	Location	Well Depth (ft)	Depth to Water (ft)	Present Use	Condition
1	(b)(6) [redacted] Kent, WA	T22N R4E Sec. 27 1/4NW 1/4NE	137	79	Private (1 home)	Operating
2	(b)(6) [redacted] Kent, WA	T22N R4E Sec. 27 1/4SE 1/4NE	39	17	Private (1 home)	Operating
3	(b)(6) [redacted] Kent, WA	T22N R4E Sec. 27 1/3SE 1/4NE	30	6	Domestic (1 home)	Operating
5	Hayett Water System 26612 Lake Fenwick Rd. Kent, WA	T22N R4E Sec. 27 1/4NE 1/4SE	84	43	Private (2 homes)	Operating
6	Lake Fenwick Supply 26425 Lake Fenwick Rd. Kent, WA	T22N R4E Sec. 27 1/4SE 1/4NE	165		Private (9 homes)	Operating
11A	(b)(6) [redacted] Kent, WA	T22N R4E Sec. 21 1/3NE 1/4NW	36 (Dug)	9	Unused	Covered Operable
11B	(b)(6) [redacted] Kent, WA	T22N R4E Sec. 21 1/4NE 1/4NW	(Dug)		Unused	Unknown
12	(b)(6) [redacted]	T22N R4E Sec. 21 1/4SW 1/4SW	125	3	Unused	Unknown
13	(b)(6) [redacted] Kent, WA	T22N R4E Sec. 22 1/4SW 1/4SE	160	50	Private (1 home)	Operating

Table 4.1 (Cont.)

Well #	Owner/Property Address	Location	Well Depth (ft)	Depth to Water (ft)	Present Use	Condition
15	(b)(6) [redacted] Kent, WA	T22N R4E Sec. 27 1/4NE 1/4NE	120		Unused	Operable
16	(b)(6) [redacted] Kent, WA	T22N R4E Sec. 27 1/4NE 1/4NE	153	121	Unused	Unknown
19	(b)(6) [redacted] Kent, WA	T22N R4E Sec. 28 1/4NW 1/4NW	27	3	Lawn Care	Operating
20	(b)(6) [redacted] Kent, WA	T22N R4E Sec. 28 1/4SW 1/4NW	265	57	Unused	Covered Condition unknown
22	(b)(6) [redacted] Kent, WA	T22N R4E Sec. 28 1/4SW 1/4NE	27	9	Unused	Covered Operable
25	(b)(6) [redacted] Kent, WA	T22N R4E Sec. 28 1/4NE 1/4SW	96	35	Unused	Covered Condition unknown
26	(b)(6) [redacted] Kent, WA	T22N R4E Sec. 28 1/4NE 1/4SW	30		Unused	Operable
28	(b)(6) [redacted] Kent, WA	T22N R4E Sec. 28	11	4	Unused	Covered Operable
31A	(b)(6) [redacted] Kent, WA	T22N R4E Sec. 29 1/4NE 1/4SE	45	32	Unused	Covered Operable

Table 4.1 (Cont.)

Well #	Owner/Property Address	Location	Well Depth (ft)	Depth to Water (ft)	Present Use	Condition
31B	(b)(6) [redacted] Kent, WA	T22N R4E Sec. 29 1/4NE 1/4SE			Unused	Operable
31C	(b)(6) [redacted] Kent, WA	T22N R4E Sec. 29 1/4NE 1/4SE			Unused	Operable
31D	(b)(6) [redacted] Kent, WA	T22N R4E Sec. 29 1/4NE 1/4SE	42		Unused	Covered Condition unknown
37	(b)(6) [redacted] Kent, WA	T22N R4E Sec. 21 1/4NW 1/4SE	200		Unused	Covered Operable
38	Marcus Whitman Church 2130 S. 248th Kent, WA	T22N R4E Sec. 21 1/4NE 1/4SW			Unused	Covered Operable
54	(b)(6) [redacted] Kent, WA	T22N R4E Sec. 21 1/4SE 1/4SW			Private	May be operating
55	(b)(6) [redacted] Kent, WA	T22N R4E Sec. 21 1/4NW 1/4SW			Unused	Covered by rock. Condi- tion unknown
56	(b)(6) [redacted] Kent, WA	T44N R4E Sec. 21 1/4SE 1/4NW			Unknown (not a drinking water well)	Unknown
57	City of Kent Linda Heights Park S. 246th St. & I-5		425	Dry	Unused	Capped

Table 4.1 (Cont.)

Well #	Owner/Property Address	Location	Well Depth (ft)	Depth to Water (ft)	Present Use	Condition
58	City of Kent City of Kent Water Tower S. of S. 246th St. & E. of Military Rd.		557	302	Unused	Capped
59	Water District #75 Well #5 P.O. Box 68100 Seattle, WA		146		Unused	Unknown
60	Water District #75 Well #8 (Same address)		242	61	Unused	Unknown
61	Water District #75 Well #14 (Same address)		165	15	Unused	Unknown

Note: Well numbers were assigned for the inventory. Missing numbers in a sequence represent wells that are no longer in existence or operable, or wells that lie outside a one-mile radius of the landfill.

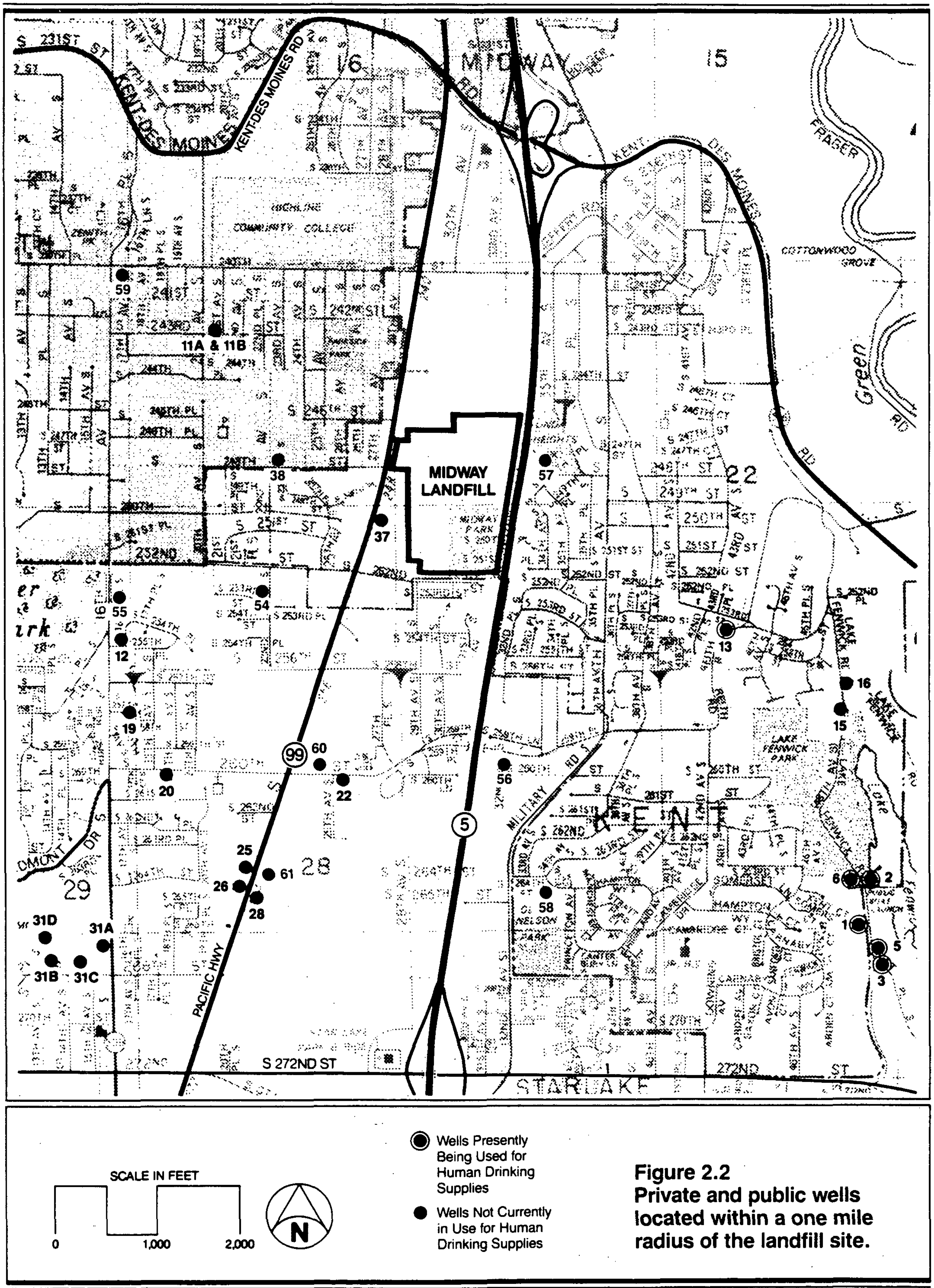
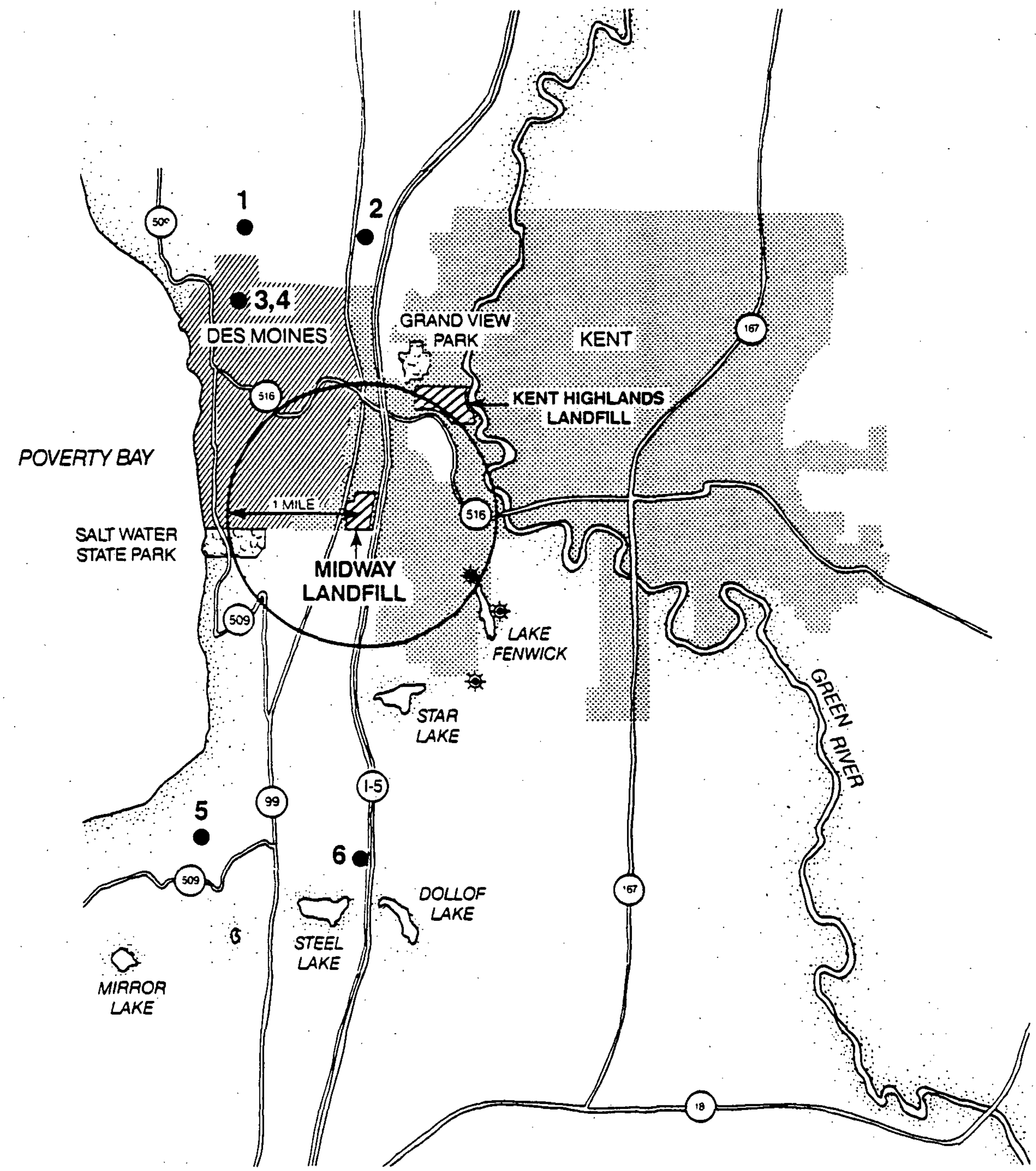
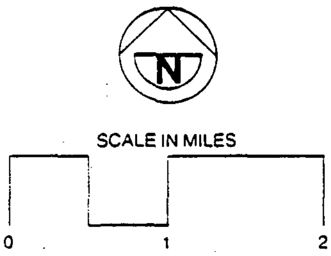


Figure 2.2
Private and public wells located within a one mile radius of the landfill site.



SOURCE: DRAFT MIDWAY LANDFILL REMEDIAL INVESTIGATION SUMMARY REPORT (01/19/88)



- Privately-Owned Domestic Supply Wells
- 1,2 Water District #75 2 Wells in Construction
- 3,4 Water District #54 2 Wells in Use, 1 New Well Proposed at Same Location
- 5 Water District #56 No Wells, Springs Used as Water Source
- 6 Water District #124 One Existing Well Shown, Other Wells Located Further South

Figure 2.3 Location of Public Water Supply Wells Within a Five Mile Radius of Site

- Drive-in theatre to the north of the landfill

- Businesses along the Highway 99 (Pacific Highway South) corridor to the west of the landfill

o Human populations utilizing the following parks:

- Linda Heights Park
- Lake Fenwick Park
- Salt Water State Park
- Grand View Park

o Human populations utilizing the following schools:

- Parkside Elementary School
- Sunnycrest Elementary School
- Highline Community College

o Human populations utilizing the following day care centers [search not complete]:
  - Day care center at church on Military Road

o Human populations in health care facilities in the landfill vicinity [search not complete]

Potential impacts to sensitive subpopulations should be examined in greater detail in the Endangerment Assessment to be conducted as part of the Midway Landfill Feasibility Study. Sensitive subpopulations may include, but are not limited to, the following:

o Pregnant women

- Infants; young children (including those at day care centers or attending nursery or elementary schools in the vicinity of the Midway Landfill)

- The elderly or infirm, including those currently being treated in health care facilities such as nursing homes and hospitals, and those with pre-existing medical conditions predisposing them to higher risk from exposure to substances potentially migrating from the site, but not currently being treated as in-patients at local health care facilities

2.4 ENVIRONMENTAL POPULATIONS

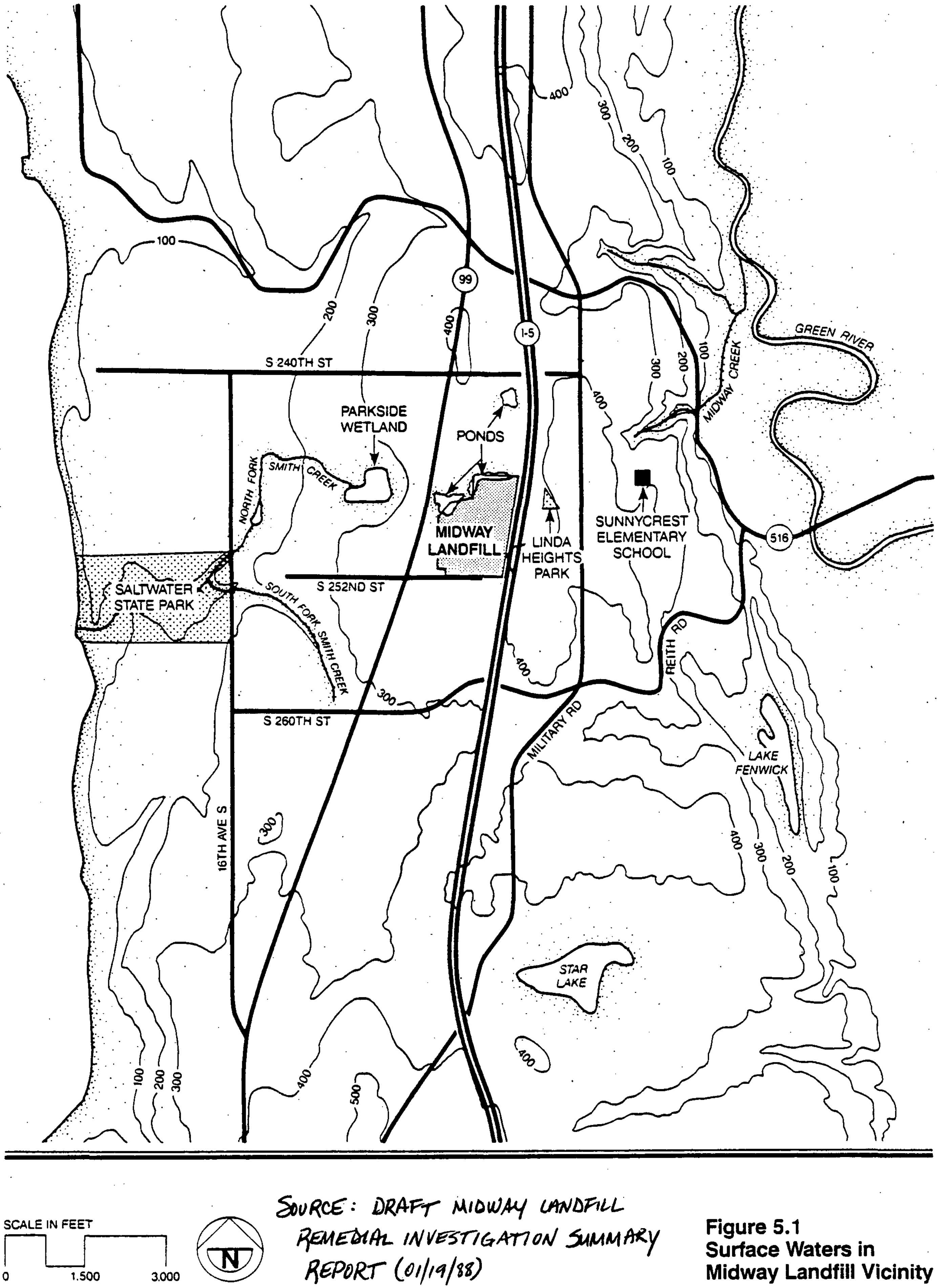
Environmental populations which may include potential receptors of substances from the Midway Landfill include:

- Wildlife populations on or near the landfill, including those dependent on surface water present at the following locations (see Figure 5.1; Source: Draft Midway Remedial Investigation Summary Report; draft dated 01/19/88.

    - Parkside Wetland, a six-acre wetland area to the west of the landfill and east of the Parkside elementary school

    - Smith Creek, located approximately 3,000 feet southwest of the Midway Landfill

    - Midway Creek, located approximately 2,000 feet east of the Midway Landfill



SOURCE: DRAFT MIDWAY LANDFILL REMEDIAL INVESTIGATION SUMMARY REPORT (01/19/88)

Figure 5.1
Surface Waters in Midway Landfill Vicinity

- Green River, located approximately one mile east of the Midway Landfill

- Lake Fenwick, located approximately one mile southeast of the Midway Landfill

- Poverty Bay/Saltwater State Park, located approximately one mile west-southwest of the Midway Landfill

- Star Lake, located approximately 1.5 miles south-southeast of the Midway Landfill

- Dollof Lake, located approximately 3 miles south of the Midway Landfill

- Steel Lake, located approximately 3 miles south of the Midway Landfill

- Mirror Lake, located approximately 4 miles south-southwest of the Midway Landfill

The natural environment in the vicinity of the Midway Landfill is described in the following sections of the Draft Environmental Impact Statement for the Midway Landfill Closure Plan (Parametrix, Inc., 1985):

- o Vegetation and Wildlife: Section (II)(A)(5)

- o Fisheries: Section (II)(A)(6)

No endangered or rare species are listed for the Midway Landfill vicinity nor have any been observed. Typical urban species such as sparrow, robin, starling, northern junco, chickadee, ducks, and small mammals such as mice and voles have been observed. Smith Creek, Midway Creek, and the Green River, all within a one-mile radius of the landfill, provide some spawning and rearing habitat for salmonid species and trout.

3.0 PRELIMINARY ENDANGERMENT ASSESSMENT

The remedial investigation must provide information concerning potential risks to public health and environment from contaminants leaving the site. The feasibility study builds on this preliminary endangerment assessment and uses it in the selection of remedial actions.

Studies undertaken for the remedial investigation show that since implementation of emergency remedial actions, including the soil cover on the landfill and the installation of the gas migration control system, very little contamination is leaving the landfill by any pathway. Air quality studies concluded that the landfill does not appear to be contributing airborne contaminants to the environment at greater levels than are normally found in urban areas. Combustible gas was effectively removed from structures surrounding the landfill and is no longer migrating off-site. Surface water does not exit the landfill, and surface water in the vicinity of the landfill is not contaminated. Current evidence suggests that a contaminant plume of groundwater to the south of the landfill does not originate in the landfill. Thus, landfill contaminants do not appear to reach receptors by any pathway in concentrations sufficiently high to warrant quantitative assessment of endangerment.

The following is a review of the data presented in the Draft Midway Landfill Remedial Investigation Summary Report, Sections 4.0, 5.0, 6.0, and 7.0, summarizing the nature of contamination found, the extent of its migration, and the potential receptors identified. It must be emphasized that potential receptors are not necessarily at risk, and, in fact, according to the evidence presented here, are not at risk.

3.1 DATA REVIEW

3.1.1 Hydrogeologic Investigations

The Draft Midway Landfill Remedial Investigation Groundwater Technical Report is being prepared; the findings of this report will be included in the final Preliminary Endangerment Assessment Report. Preliminary results of the RI Groundwater Technical Report, to date, are presented below; it should be understood that these data are subject to change in future drafts of the RI Groundwater Technical Report.

Data Obtained and Sampling Methods. Leachate and groundwater samples were taken from two onsite leachate monitoring wells and from approximately 40 locations surrounding the landfill, including 29 monitoring wells, 8 boreholes, and 2 private wells. Multiple samples were taken from October 1986 to September 1987, totalling 4 samples each for most of the wells. Additional sampling is planned. Samples were obtained according to procedures outlined in the Final Sampling and Analysis Plan (Black & Veatch, 1986b) and the Quality Assurance Project Plan (Parametrix, Inc., 1986).

Nature of Contamination. Samples were analyzed for all substances on the Hazardous Substances List and also for conventional water quality parameters. A number of volatile organic compounds were detected. Drinking water standards were exceeded for vinyl chloride and 1,2-dichloroethane. Other compounds were detected at concentrations below drinking water standards. Table 2 lists USEPA Hazardous Substances List Volatile Organic Compounds (HSL VOCs) detected in leachate and groundwater samples collected in the vicinity of the Midway Landfill.

Table 2. USEPA Hazardous Substances List Volatile Organic Compounds (HSL VOCs) detected in groundwater and leachate in wells in and around the Midway Landfill.

Compound	Leachate	Groundwater
Acetone	x	x
Benzene	x	x
Bromoform		x
2-Butanone	x	x
Carbon Disulfide		x
Chlorobenzene	x	x
Chloroethane		x
Chloroform[1]	--	--
Chloromethane	x	
1,1-Dichloroethane		x
1,2-Dichloroethane		x
1,1-Dichloroethene		x
Trans 1,2 Dichloroethene	x	x
Ethyl Benzene	x	x
2-Hexanone	x	x
Methylene Chloride	x	x
2-Methyl-2-pentanone	x	x
Styrene		x
Tetrachloroethene		x
Toluene	x	x
1,1,1-Trichloroethane		x
1,1,2-Trichloroethane		x
Trichloroethene	x	x
Vinyl Acetate		x
Vinyl Chloride	x	x
Xylenes	x	x

(1) Chloroform data is suspect in terms of quality assurance. Concentrations equal to those reported for environmental samples were also detected in blanks.

Migration Pathways and Extent. Earlier studies (Golder Associates, 1982; 1985) established that the Midway Landfill is located in a region of advance glacial outwash deposits of overconsolidated sand and gravel with minor amounts of silt. The complex layers of slightly varying glacial deposits are further complicated by the effects of the gravel mining operation that preceded the landfill. Years of taking water from the lake formerly at the site to wash the gravel resulted in thick layers of silt both on the lake bottom and at the bottom of the gravel pit. Evidence from boreholes and monitoring wells drilled for the remedial investigation established the existence of a discontinuous clay aquitard (a layer of relatively low permeability) passing diagonally beneath the landfill northeast to southwest, approximately 150 feet below ground surface. This aquitard creates a perched water table and appears to divide the groundwater beneath the site so that it moves laterally to the southeast or northwest before moving downward into the upper gravel aquifer that is the primary path of groundwater and potential receptor of leachate from the landfill.

Examination of potentiometric contours and mapped plumes indicates that some contaminants appear to have a source located offsite to the west of the landfill, centered around monitoring well MW-17A. Groundwater around this well would travel eastward, beneath the landfill, and then to the southeast. Contaminants generated onsite would join this pathway after lateral migration. This complicates ascertaining the source of contaminants that are found beneath the landfill itself.

The pattern of distribution of constituents in groundwater and leachate were compared to assess the likelihood that contaminants detected in groundwater offsite could be attributed to migration from the landfill. Chlorobenzene, ethylbenzene, and total xylenes appear to be associated with leachate, and are restricted to the landfill. Other compounds detected in both leachate and groundwater appear to have sources other than the landfill. Chloride, which is not a hazardous substance in itself, is present in leachate in high concentrations and is an excellent tracer of leachate migration. Chloride was found to be diluted to background levels (1000 mg/L to 5 mg/L) within 500 feet of the landfill.

Potential Receptors. Public water supplies within 5 miles of the site were enumerated for the Environmental Impact Statement written for the Midway Landfill Closure Plan (Parametrix, August 1985) (see Figure 2.1 above). Given the general movement toward the southeast of groundwater passing under the site, the King County Water Districts #75 and 54 wells two to three miles to the northwest are not likely receptors. No public water supply wells currently in operation are within a one-mile radius. The City of Kent has drilled two wells, originally intended as drinking water supplies, within one mile of the site; neither is currently in operation, nor are there plans to put them in operation.

The well survey conducted for the remedial investigation found 26 private wells within one mile of the landfill, only 7 of which are currently in use (see Figure 2.2). Five of these are approximately one mile southeast of the landfill.

3.1.2 Surface Water Investigation

The results of the Surface Water Investigation are described in detail in the Draft Midway Landfill Remedial Investigation Surface Water Technical Report (draft dated 01/15/88), which includes the following technical memoranda:

- Surface Water Hydraulics Technical Memorandum (Appendix A)
- Surface Water Quality Technical Memorandum (Appendix B)
- Pond Monitoring Technical Memorandum (Appendix C)
- Seeps and Soils Technical Memorandum (Appendix D)
- Washington Department of Ecology's Surface Water Sampling Report (Appendix E)

Data Obtained and Sampling Methods. Field surveys of the landfill and its vicinity were conducted to locate major and minor surface water bodies and drainages. Stormwater quality target parameters are listed in Table 4.2 (Source: Draft Midway Landfill RI/FS Surface Water Technical Report; draft dated 01/15/88). Surface water quality target parameters are listed in Table 4.3 (Source: Draft Midway Landfill RI/FS Surface Water Technical Report; draft dated 01/15/88). Seep water quality and soil quality at seep locations target parameters are listed in Table 4.4 (Source: Draft Midway Landfill RI/FS Surface Water Technical Report; draft dated 01/15/88). Sampling locations for surface water quality, stormwater quality, seeps water quality, and surface soils at seep locations are shown in Figure 4.1 (Source: Draft Midway Landfill RI/FS Surface Water Technical Report; draft dated 01/15/88). Stormwater flow into the landfill was measured at four storm drain outlets discharging into the North Pond or the depression between Linda Heights Park and I-5, which in turn is collected in a 30-inch-diameter corrugated metal pipe and discharged directly into the waste approximately 50 feet below the surface. Soil samples were taken from several locations surrounding the landfill and analyzed for CERCLA and conventional parameters as well as grain size.

All water samples were collected directly into laboratory prepared containers or grabbed into clean plastic containers (for field filtering into the laboratory supplied bottle for metals analysis). The portion of the sample for metals analysis was pumped (by peristaltic pump) through a 0.45 micron filter and into the preserved sample bottle. The filter was changed between each sample and the pump tubing and filter holder rinsed with hydrochloric acid, followed by a distilled water rinse. All samples were placed on ice after collection and accompanied to the analytical laboratory with proper chain-of-custody forms. Completed chain-of-custody forms for all samples are in the project data accession files.

Table 4.2. Stormwater quality parameters.

Parameters	Samples
Conventional	
Ions (B, Ca, Mg, Na, K, Fe, Mn)	SW-1 composite
SO_4	and
Fluoride	SW-2 composite
Total Kjeldahl Nitrogen	
Nitrate Nitrogen	
Phosphorous as PO_4	
Alkalinity	
Hardness	
Total Organic Halogen	
Extended Conventionals	
Total Dissolved Solids	SW-1 (1830 hrs)
Total Suspended Solids	SW-2 (1830 hrs)
Chemical Oxygen Demand	
CERCLA	
Dissolved Metals (Sb, As, Sc, Ag, Tl, Be, Cr, Cu, Ni, Pb, Zn)	SW-1 composite and
Acid Extractable Organics	SW-2 composite
Base Neutral Organics	
Pesticides and PCBs	
Volatile Organics	SW-1C (grab)
	SW-2 (grab)

Table 4.3 Surface water quality parameters.

Parameters	Samples
Field	SW-3, 5 through 32
pH Temperature Conductivity	
Conventional	SW-3, 5 through 12, and 21 through 23
Ions (B, Ca, Mg, Na, K, Fe, Mn) Sulfate Fluoride Total Dissolved Solids Total Suspended Solids Total Kjeldahl Nitrogen Nitrate Nitrogen Phosphorus as PO4 Alkalinity Hardness BOD-5 Chemical Oxygen Demand Total Organic Halogen Fecal Coliform	
CERCLA	SW-3, 5 through 9, 11
Dissolved Metals (Sb, As, Se, Ag, Tl, Be, Cd, Cr, Cu, Ni, Pb, Zn) Volatile Organics Acid Extractable Organics Base Neutral Organics Pesticides and PCBs	

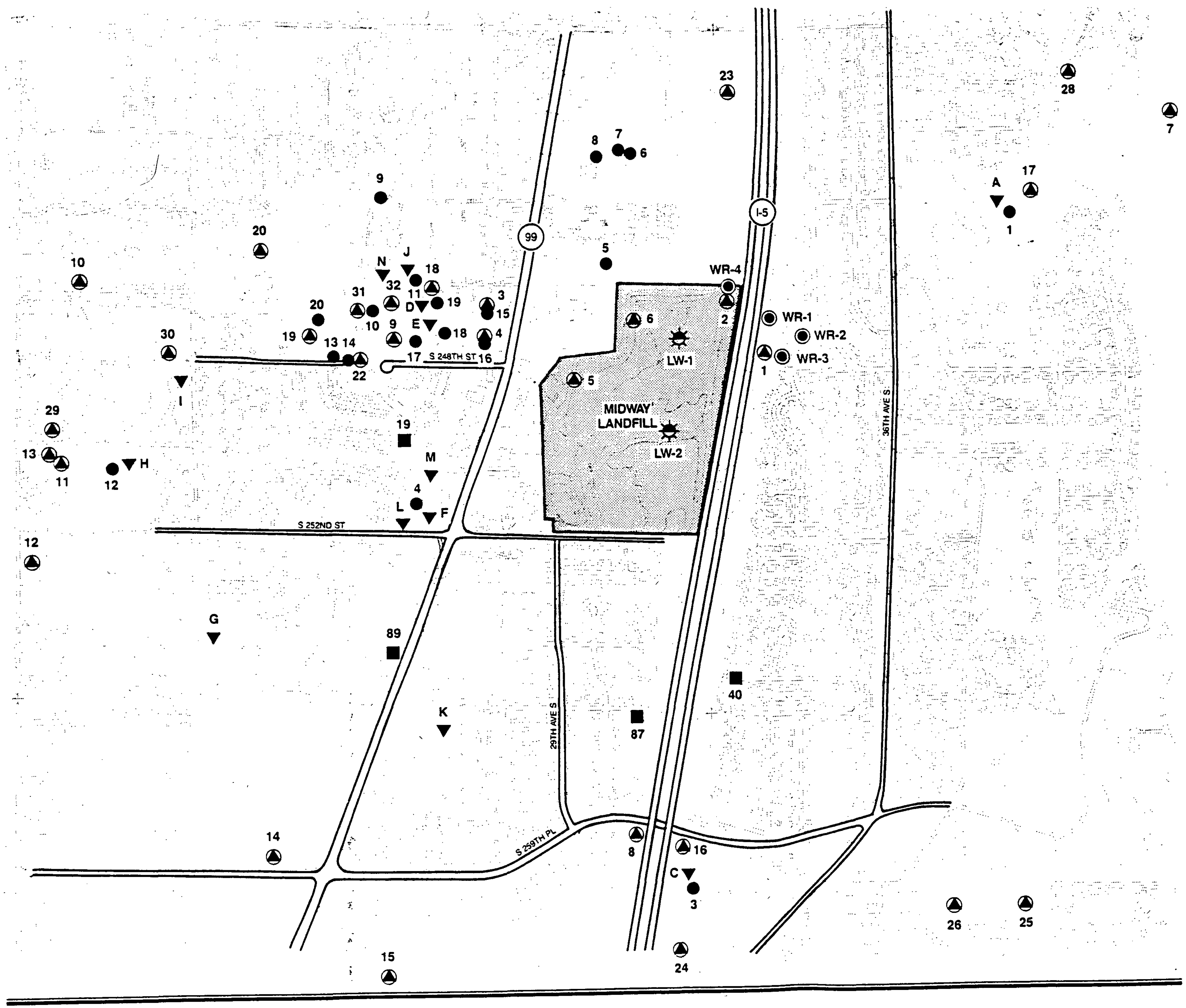
Table 4.4 Seep water quality and soil quality parameters.

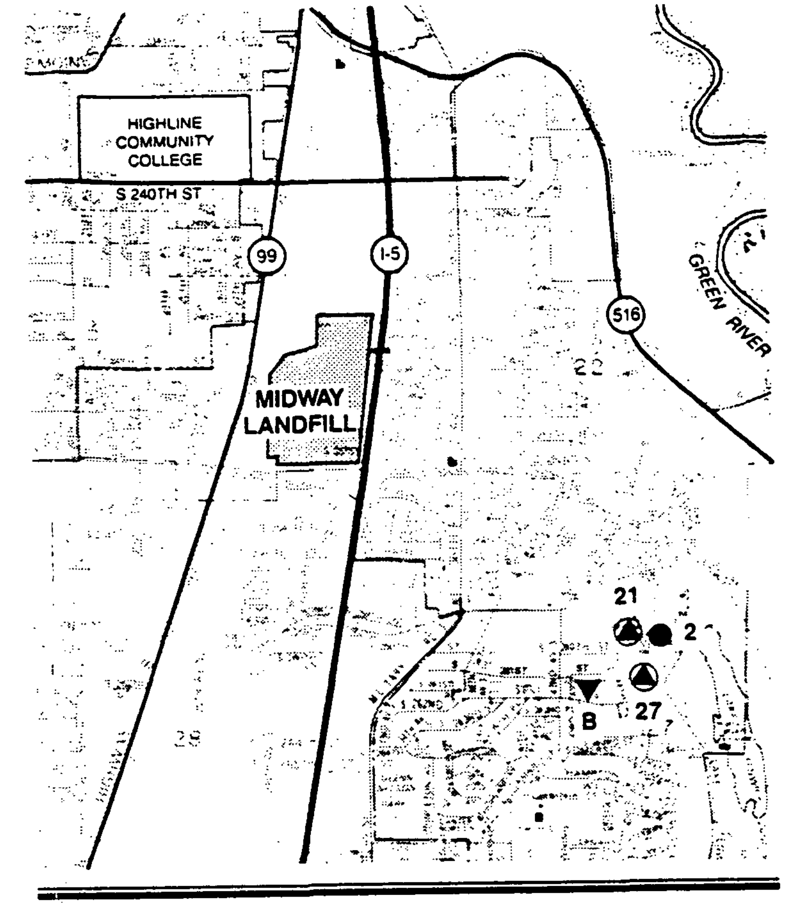
SEEP SAMPLES

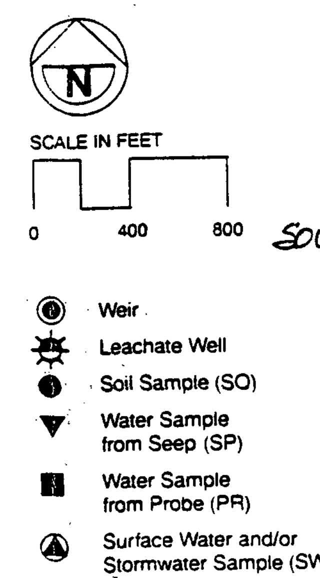
Parameters	Samples
Field	All seep samples
pH Temperature Conductivity	
Conventional	SP-A through J
Ions (B, Ca, Mg, Na, K, Fe, Mn) Sulfate Fluoride Total Dissolved Solids Total Suspended Solids Total Kjeldahl Nitrogen Nitrate Nitrogen Phosphorus as P04 Alkalinity Hardness BOD-5 Chemical Oxygen Demand Total Organic Halogen Fecal Coliform	
CERCLA	SP-A, D through G
Dissolved Metals (Sb, As, Se, Ag, Tb, Be, Cd, Cr, Cu, Ni, Pb, Zn) Volatile Organics Acid Extractable Organics Base Neutral Organics Pesticides and PCBs	

SOIL SAMPLES

Parameters	Samples
pH (saturated paste) Conductivity (saturated Paste) Grain Size Analysis CERCLA Parameters (as above)	All soil samples







SOURCE: DRAFT MIDWAY LANDFILL RI/FS SURFACE WATER TECHNICAL REPORT (01/15/88)

Figure 5.3
Sampling Locations

The number and type of samples collected for the seeps and soils investigation are shown in Table 4.1 (Source: Draft Midway Landfill RI/FS Surface Water Technical Report, draft dated 01/15/88, Appendix D--Seeps and Soils Technical Memorandum--Task 2.4). Soil samples taken from seep locations were collected using a hand auger to obtain samples to a depth of two feet. Soil samples at other locations were collected using a stainless steel hand trowel to obtain samples to a depth of six inches. All samples except the three samples to the north of the landfill were field composited. For the composite samples, three subsamples from the vicinity of interest were placed into stainless steel bowls, mixed well, and transferred to the jars supplied by the analytical laboratory. The discrete samples were placed directly into the sample containers. All sampling and compositing equipment was thoroughly cleaned between samples as described in Appendix D of the Surface Water Technical Report. All soil samples were keep on ice and accompanied to the laboratory with chain-of-custody forms.

Nature and Extent of Contamination. Detailed analytical results of surface water and stormwater samples are documented separately in Appendix B-1 of the Surface Water Quality Technical Memorandum (Source: Draft Midway Landfill RI/FS Surface Water Technical Report, draft dated 01/15/88, Appendix B: Surface Water Quality Technical Memorandum, Appendix B-1--Task 2.3.2). Ranges of conventional parameters found in Midway surface water samples and local Puget Sound urban runoff are shown in Table 5.2 (Source: Draft Midway Landfill RI/FS Surface Water Technical Report; draft dated 01/15/88). Ranges of metals found in Midway surface water samples and local Puget Sound urban runoff are shown in Table 5.3 (Source: Draft Midway Landfill RI/FS Surface Water Technical Report; draft dated 01/15/88). Ranges of conventional parameters found in Midway stormwater samples and local Puget Sound urban runoff are shown in Table 5.4 (Source: Draft Midway Landfill RI/FS Surface Water Technical Report; draft dated 01/15/88). Ranges of metals found in Midway stormwater samples and local Puget Sound urban runoff are shown in

Table 4.1. Number and type of samples collected for the seeps and soils investigation.

Sample Type	Collection Method	Analysis	Number of Samples	Sample Location
Probes				
Probe	Peristaltic Pump	F, C	4	Probes 19, 89S, 87S, 40
Seeps				
Seep	Grab	F	4	K, L, M, N
Seep	Grab	F, C	5	B, C, H, I, J
Seep	Grab	F, C, R	5	A, D, E, F, G
Field Blank	Grab	F, C	2	FB-1 and FB-2
Field Blank	Grab	R	1	FB-1
Replicate	Grab	F, C, R	1	SP-E-R
Duplicate	Grab	F, C	2	SP-E-D and SP-I-D
Duplicate	Grab	R	1	SP-E-D
Soils				
Soil	Composite	R, G	17	1 - 5, 9 - 20
Soil	Discrete	R, G	3	6, 7, 8
Replicate	Composite	R, G	1	SO-17-R
Duplicate	Composite	R, G	1	SO-10-D
Field Blank	Grab (water)	R	1	FB-1
Rinsate	Grab (water)	R	1	SO-RI

F = field parameters
C = conventional parameters
R = CERCLA parameters
G = grain size and saturated paste pH and conductivity

Table 5.2. Comparison of Midway surface water samples and local Puget Sound urban runoff -- conventional parameters. All units in mg/L (ppm) unless otherwise noted.

Parameters	Midway Surface Water	Urban Runoff
Biochemical Oxygen Demand	<1.0-7.6	<0.1-40[a]
Chemical Oxygen Demand	5-80	13-150[b]
Sulfate	<10-24.0	2.6-61[b]
Total Kjeldahl Nitrogen	<0.05-0.77	<0.5-5.9[a]
Nitrate as Nitrogen*	<0.05-2.9	<0.01-4.5[b]
Phosphate as Phosphorous	<0.05-0.14	0.02-9.20[b]
Fluoride	<0.5	0.1-0.4[b]
Alkalinity	9.6-168	0-25[b]
Hardness	7.5-189	7-170[b]
Total Dissolved Solids	38-312	8-788[b]
Total Suspended Solids	6-14400	1-2740[b]
Total Organic Halides	<0.008-0.041	<0.02-0.07[c]
Fecal Coliform (MPN/100ml)	<2-1600	1-66,000[b]
pH (units)	5.0-7.3	5.2-7.4[a]
Conductivity (umhos/cm)	25-362	16-300[a]

a = Pitt (1984)
b = Ebbert et al. (1985)
c = Kennedy, Jenks, Chilton (1987)
NT = Not tested
*Midway samples analyzed as nitrate; Ebbert et al. (1985) samples analyzed as nitrate plus nitrite.

Table 5.3. Ranges of metals found in Midway Surface water samples and local Puget Sound urban runoff. All units in mg/L (ppm).

Parameters	Midway Surface Water	Urban Runoff
Zinc	0.02-0.06	0.028-0.250[a]
Nickel	<0.01-0.01	<0.003-0.032[a]
Chromium	<0.01	0.002-0.019[a]
Copper	<0.02	0.004-0.046[a]
Silver	<0.05	<0.0002-0.0006[a]
Beryllium	<0.02	<0.0003[a]
Boron	<0.2	NT[a,b]
Calcium	3.0-22.6	2.3-34[b]
Magnesium	<0.05-10.6	0.3-20[b]
Sodium	16.4-31.4	0.9-210[b]
Potassium	<1.0-2.7	0.6-11[b]
Iron	0.08-1.5	NT[a,b]
Manganese	<0.01-0.08	NT[a,b]
Antimony	<0.002	<0.003[a]
Arsenic	<0.002	0.003-0.037[a]
Selenium	<0.002	<0.002[a]
Lead	<0.002-0.004	0.06-0.460[a]
Cadmium	<0.0004	≤0.0001-0.0019[a]
Thallium	<0.002	≤0.001[a]

a = Metro (1982)
b = Ebbert et al. (1985)
NT = Not tested

Table 5.4. Ranges of conventional parameters found in Midway stormwater samples and local Puget Sound urban runoff. All units in mg/L (ppm) unless otherwise noted.

Parameters	Midway Stormwater	Urban Runoff
Chemical Oxygen Demand	40-70	13-150[a]
Sulfate	11.7-73.0	2.6-61[b]
Total Kjeldahl Nitrogen	0.56-1.1	<0.5-5.9[a]
Nitrate as Nitrogen*	0.81-14.3	<0.01-4.5[b]
Ortho Phosphate+	<0.02-0.75	<0.01-9.2[b]
Fluoride	<0.5	0.1-0.4[b]
Alkalinity	19-33	0-25[b]
Hardness	14.0-118	7-170[b]
Total Dissolved Solids	21-232	8-788[b]
Total Suspended Solids	<10-72	1-2740[b]
Total Organic Halides	0.015-0.028	<0.02-0.07[c]
pH (units)	7.2-8.0	5.2-7.4[a]
Conductivity (umhos/cm)	40-285	16-300[a]

a = Pitt (1984)
b = Ebbert et al. (1985)
c = Kennedy, Jenks, Chilton (1987)
*Midway samples analyzed as nitrate; Ebbert et al. (1985) analyzed as nitrate plus nitrite.
+Midway samples analyzed as ortho phosphate; Ebbert et al. (1985) analyzed as total phosphorus.

Table 5.5 (<u>Source</u>: Draft Midway Landfill RI/FS Surface Water Technical Report; draft dated 01/15/88).

Concentrations of all surface water and stormwater parameters analyzed were comparable to that of normal urban runoff as measured in other urban areas of Puget Sound. The levels of most metals tested were at or below the detection limits. No pesticides or PCBs were found in any of the samples. Only two samples contained detectable levels of volatile or semivolatile organics, both from the same site, a swamp to the west of the landfill.

Detailed analytical results of seep and probe water samples are documented separately in Appendix D-3 of the Seeps and Soils Technical Memorandum (<u>Source</u>: Draft Midway Landfill RI/FS Surface Water Technical Report, draft dated 01/15/88, Appendix D: Seeps and Soils Technical Memorandum, Appendix D-3--Task 2.4). The results of conventional, bacteriological and field testing of seep samples showed no notable results. The concentrations of most of the metals analyzed were at or near the detection limits; levels of antimony, iron, manganese, calcium, magnesium, sodium and potassium detected in the samples were within the ranges expected for groundwaters in King County. No pesticides or PCBs were detected in any of the seep samples. Only sample SP-F, taken adjacent to the former location of a gasoline station, showed detectable levels of volatile organics.

Detailed analytical results for soil samples are documented in Appendix D-4 of the Seeps and Soils Technical Memorandum (<u>Source</u>: Draft Midway Landfill RI/FS Surface Water Technical Report, draft dated 01/15/88, Appendix D: Seeps and Soils Technical Memorandum, Appendix D-4--Task 2.4). The soil samples were predominantly sand with two samples from the wetland shown to be predominantly silt and clay. Metals analysis of the soils samples showed a wide range of values for all metals tested (except for silver, selenium, thallium and mercury, which were all at or below detection limits). For the most part, values fell within the ranges seen for naturally occurring soils.

Table 5.5. Ranges of metals found in Midway stormwater samples and local Puget Sound urban runoff. All units in mg/L (ppm).

Parameters	Midway Stormwater	Urban Runoff
Zinc	0.06-0.22	0.028-0.250[a]
Nickel	<0.01-0.04	<0.003-0.032[a]
Chromium	<0.01	0.002-0.019[a]
Copper	<0.02-0.03	0.004-0.046[a]
Silver	<0.05	<0.0002-0.0006[a]
Beryllium	<0.01	<0.0003[a]
Boron	<0.1-2.5	NT[a,b]
Calcium	4.4-36.6	2.3-34[b]
Magnesium	0.06-6.5	0.3-20[b]
Sodium	0.4-32.4	0.9-210[b]
Potassium	<1.0-3.3	0.6-11[b]
Iron	<0.01-0.08	NT[a,b]
Manganese	<0.01-0.02	NT[a,b]
Antimony	<0.002	<0.003[a]
Arsenic	<0.002-0.010	0.003-0.037[a]
Selenium	<0.002-0.003	<0.002[a]
Lead	<0.002-0.03	0.06-0.460[a]
Cadmium	0.0012-0.0046	≤0.0001-0.0019[a]
Thallium	<0.002	≤0.001[a]

a = Metro (1982)
b = Ebbert et al. (1985)
NT = Not tested

The chief exception to this was sample SO-4, which showed high levels of zinc, copper, arsenic, cadmium, lead and antimony. This sample was taken from the soils at SP-F, located downslope from the former location of a gasoline station. This area has been covered over with what is believed to be slag from the ASARCO (Tacoma) smelter.

No pesticides were found in any soil samples. The PCB Arochlor 1260 was detected in sample SO-19 at 1.1 ppm. The presence of this low level in one soil sample probably does not signify a problem related to the landfill since no possible routes to the soil sampling site (surface water or groundwater) show PCB contamination.

Most volatile organics were undetected in the soil samples, but low levels of carbon disulfide, benzene, tetrachloroethene, toluene and chlorobenzene were detected in several samples. These levels were not determined significant because they were very low, i.e., below 1 ppm. The majority of semivolatile organics detected were found in three samples: SO-8, 15 and 16. Samples SO-15 and 16 were taken from storm drainages along Highway 99 and highway runoff could account for the organics detected. Sample SO-8 was taken adjacent to the Widing Trucking property to the north of the landfill. Compounds detected in this sample may be attributable to runoff from the property.

<u>Migration Pathways and Extent of Contamination</u>. The RI studies found no evidence that the Midway Landfill has a detrimental impact on the quality of surface water or soils in the vicinity of the landfill. There is no direct discharge of surface water from the landfill into any surrounding surface water bodies. Seeps emerging from the ground in the vicinity of the landfill do not show evidence of contamination.

<u>Potential Receptors</u>. Because the landfill receives but does not discharge surface water, the only potential receptor of contaminated surface waters on

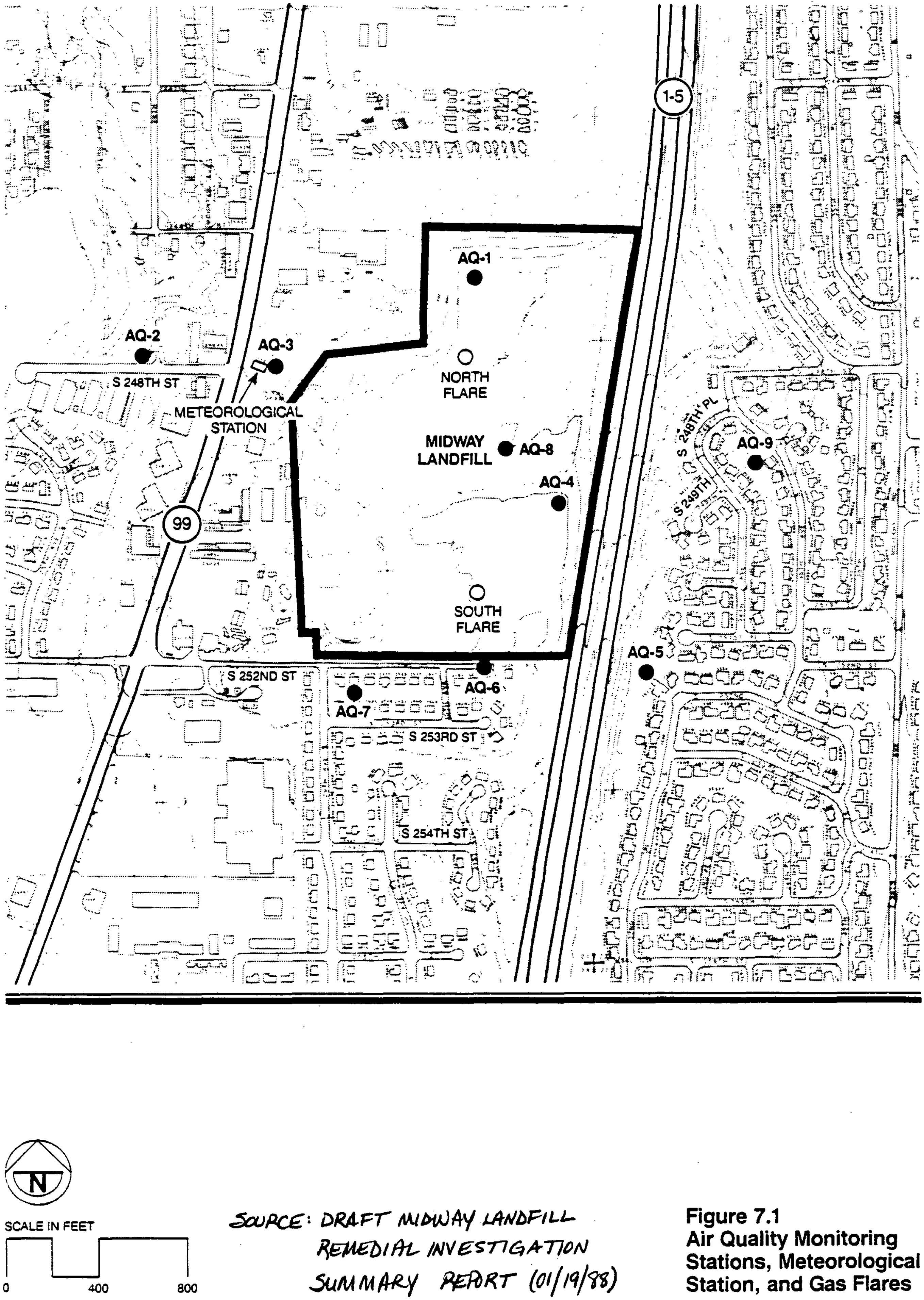
the landfill is the groundwater aquifer beneath the landfill, which might receive such contamination by infiltration or percolation. Groundwater studies are reported in section 4.0.

3.1.3 Ambient Air Quality Investigations

The ambient air quality investigations are discussed here separately from the landfill gas studies, although their subject matter overlaps. These results are discussed in detail in the Draft Midway Landfill Remedial Investigation Air Quality Technical Report, which summarizes the results of the RI Air Quality Investigations.

Data Obtained and Sampling Methods. Landfill surface emissions to ambient air were sampled from 7 sampling stations located onsite and offsite (Figure 7.1; Source: Draft Midway Landfill Remedial Investigation Summary Report, 01/19/88), in combinations intended to provide upwind, downwind, and background ambient air comparisons. Samples were obtained by drawing ambient air through a modified Volatile Organic Sampling Train (VOST) apparatus that included a pair of adsorbent tubes, the first packed with Tenax-GC resin and the second with approximately a 3:1 ratio of Tenax and charcoal. Total sampling time per sample was approximately two hours, resulting in a total sample volume of approximately 12 liters. Samples were analyzed for the USEPA Hazardous Substances List Volatile Organic Compounds listed in Table 6.1 (Source: Preliminary Draft Midway Remedial Investigation Summary Report; draft dated 12/21/87).

The two existing temporary onsite landfill gas flares were sampled at the gas inlet and at a point near the top of the flame. Samples were analyzed for selected volatile organic compounds (i.e., those listed in Tables _______-_________, currently being revised by TRC), hydrogen cyanide, hydrogen chloride, hydrogen sulfide, carbon dioxide and oxygen. In general, sampling and analysis followed the procedures detailed in EPA's Protocol for the



SOURCE: DRAFT MIDWAY LANDFILL
REMEDIAL INVESTIGATION
SUMMARY REPORT (01/19/88)

Figure 7.1
Air Quality Monitoring Stations, Meteorological Station, and Gas Flares

Table 6.1 Target compounds for the air quality monitoring program.

Compounds	
Trichlorofluoromethane	Acetone
1,1-Dichloroethene	2-butanone
Methylene Chloride	Hexane
trans-1,2-Dichloroethene	Ethylbenzene (deuterated)*
1,1-Dichloroethane	Perfluorotoluene*
Chloroform	
1,1,1-Trichloroethane	
Carbon tetrachloride	
Benzene	
1,2-dichloroethane	
Trichloroethene	
1,2-Dichloropropane	
Bromodichloromethane	
trans-1,3-Dichloropropene	
Toluene	
cis-1,3-Dichloropropene	
1,1,2-Trichloroethane	
Tetrachloroethene	
Dibromochloromethane	
Chlorobenzene	
Ethyl Benzene	
M,P-Xylene	
O-Xylene	
Bromoform	
1,1,2,2-tetrachloroethane	
M-Dichlorobenzene	
P-Dichlorobenzene	
O-Dichlorobenzene	
Chloromethane	
Bromomethane	
Chloroethane	
Vinyl Chloride	
Heptane	
Isopropyl Benzene	
Styrene	
Perfluorobenzene*	

*Calibration standard

Collection and Analysis of Volatile POHCs Using VOST, March 1984. Laboratory analysis was by purge-trap-desorb gas chromatography/mass spectrometry (PTD-GC/MS) in accordance with EPA Method 624. In addition to the VOST sampling runs, grab samples were collected in Tedlar bags from each flare inlet and analyzed by modified Method 624 PTD-GC/MS procedures. Temperature was measured at various heights in each flame.

Nature of Contamination. Gas from the onsite gas extraction wells and flare manifolds contained a wide variety of substances, including numerous USEPA Hazardous Substances List Volatile Organic Compounds (HSL VOCs). HSL VOCs identified during the RI in gas samples from the onsite gas extraction wells are shown in Table 5-2 (Source: Draft Midway Landfill Remedial Investigation Gas Characterization Technical Memorandum; draft dated 01/14/88). The compounds found most frequently and in the highest concentrations onsite included ethylbenzene, vinyl chloride, total xylenes, toluene, and benzene. The maximum concentrations of these compounds were in the low parts-per-million (ppm) range. The maximum onsite concentration for any HSL VOC detected during remedial investigation sampling was 31 ppm of vinyl chloride. This result was seen in a sample taken from an onsite gas extraction well with a relatively low flow rate (well 44D-0), and probably represents an artificially high finding because of the low flow rate and increased opportunity for gas contaminant accumulation. The mean concentration of vinyl chloride across all onsite gas extraction well completions sampled was slightly less than 3 ppm. The results of pre-combustion flare gas sampling for selected volatile organic compounds conducted for the RI by TRC Environmental Consultants are shown in Table 6.2 [Note: This table is currently being revised by TRC Environmental Consultants]. The toxic inorganic gases hydrogen sulfide and carbon monoxide were also reported present onsite in the low parts-per-million range. Data for carbon monoxide are presented in Table 1 (Source: Midway Landfill Technical Discipline Report--Air Quality; submitted to Parametrix, Inc. by TRC Environmental Consultants; draft dated 10/23/87; currently undergoing revision by TRC).

Table 5-2. Concentrations (in ppb) of USEPA Hazardous Substances List Volatile Organic Compounds (HSL VOCs) in subsurface gas samples from on-site gas extraction wells sampled by Parametrix, Inc. during June-July 1987.

ON-SITE GAS EXTRACTION WELL COMPLETIONS SAMPLED — No. of Sampling Rounds = 1 (N = 14 well completions; total of 16 samples)

CAS #	USEPA Hazardous Substances List Volatile Organic Compound (USEPA HSL VOC)*	HSL VOC #	4-0	12-0	18-0	21-0	24-0	25-0	(#1 33-0	#2 33-0	#2R) 33-0	34-0	36D-0	41D-0	44D-0	PA8D-0	PD6D-0	PD12D-0	% of Sampled Well Completions Where Reportable	Maximum Reportable Concentration (ppb)	Average (Arith. Mean) Concentration (ppb)	Standard Deviation of Arith. Mean Concentration (ppb)
71-43-2	Benzene	3	102	381 E	ND	861	77	461	707	ND	ND	1,384	400	R	640	74	ND	R	71 %	1,384	318	394
75-27-4	Bromodichloromethane	4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0 %	ND	ND	ND
74-83-9	Bromomethane	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0 %	ND	ND	ND
75-25-2	Bromoform	6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0 %	ND	ND	ND
56-23-5	Carbon tetrachloride	7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0 %	ND	ND	ND
108-90-7	Chlorobenzene	8	51	ND	ND	ND	44	139	ND	ND	ND	ND	ND	ND	258	45	ND	ND	36 %	258	34	68
75-00-3	Chloroethane	9	15	708 E	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	14 %	708	45	171
110-75-8	2-Chloroethylvinyl ether	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0 %	ND	ND	ND
67-66-3	Chloroform	11	R	ND	ND	ND	R	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	0 %	ND	ND	ND
74-87-3	Chloromethane	12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0 %	ND	ND	ND
124-48-1	Dibromochloromethane	13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0 %	ND	ND	ND
75-34-3	1,1-Dichloroethane	14	12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	748	ND	ND	27	21 %	748	49	181
107-06-2	1,2-Dichloroethane	15	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	126	ND	ND	ND	7 %	126	8	31
75-35-4	1,1-Dichloroethene	16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	112	ND	ND	ND	7 %	112	7	27
156-60-5	trans-1,2-Dichloroethene	17	ND	ND	ND	ND	ND	7	ND	ND	ND	ND	ND	ND	79	ND	ND	ND	14 %	79	5	19
78-87-5	1,2-Dichloropropane	18	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0 %	ND	ND	ND
10061-01-5	cis-1,3-Dichloropropene	19	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	15	ND	ND	ND	7 %	15	1	4
10061-02-6	trans-1,3-Dichloropropene	20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0 %	ND	ND	ND
100-41-4	Ethylbenzene	21	2,467	2,444 E	2,240	6,744	371	1,924	5,544	ND	ND	566	5,205	R	16,610	430	634	16	93 %	16,610	2,825	4,133
75-09-2	Methylene chloride	22	R	2,648 E	R	R	R	R	R	R	877	R	R	R	R	R	R	R	14 %	2,648	220	662
79-34-5	1,1,2,2-Tetrachloroethane	23	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0 %	ND	ND	ND
127-18-4	Tetrachloroethene	24	7	ND	ND	ND	12	80	ND	ND	ND	ND	ND	ND	57	ND	ND	ND	29 %	80	10	23
108-88-3	Toluene	25	235	125 E	ND	1,043	70	704	ND	ND	ND	417	2,105	1,961	24,044	22	ND	R	71 %	24,044	1,920	5,751
71-55-6	1,1,1-Trichloroethane	26	R	ND	ND	ND	R	R	ND	ND	ND	ND	ND	ND	R	R	ND	ND	0 %	ND	ND	ND
79-00-5	1,1,2-Trichloroethane	27	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0 %	ND	ND	ND
79-01-6	Trichloroethene	28	ND	ND	ND	ND	5	10	ND	ND	ND	ND	ND	ND	97	2	ND	ND	29 %	97	7	23
75-01-4	Vinyl chloride	29	21	204 E	730	1,538	25	111	8,457	ND	ND	461	1,568	ND	31,215	46	538	ND	86 %	31,215	2,807	7,606
67-64-1	Acetone	30	R	ND	R	R	R	R	R	R	939	R	R	R	R	R	R	R	7 %	939	59	227
78-93-3	2-Butanone	31	R	R	ND	R	R	R	R	R	ND	R	ND	ND	R	183	R	R	7 %	183	11	44
75-15-0	Carbon disulfide	32	R	ND	ND	ND	R	R	ND	ND	ND	ND	ND	ND	R	R	ND	R	0 %	ND	ND	ND
591-78-6	2-Hexanone	33	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0 %	ND	ND	ND
108-10-1	4-Methyl-2-pentanone	34	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	6	ND	ND	7 %	6	0	1
100-42-5	Styrene	35	46	ND	ND	ND	37	53	ND	ND	ND	ND	ND	ND	508	17	ND	ND	36 %	508	41	122
108-05-4	Vinyl acetate	36	56	ND	ND	ND	ND	95	ND	ND	ND	ND	ND	ND	483	ND	ND	ND	21 %	483	40	117
1330-20-7	Xylenes (Total)	37	611	1,417 E	ND	2,965	104	1,743	4,323	7	ND	ND	11,090	3,168	29,195	72	ND	11	79 %	29,195	3,419	7,208
109-99-9	Tetrahydrofuran	91 *	R	1,493 E	ND	R	R	R	R	ND	ND	R	ND	ND	R	2,099	R	R	14 %	2,099	224	604
75-69-4	Trichlorofluoromethane	92 *	ND	ND	ND	ND	357	R	ND	ND	ND	ND	ND	ND	R	44	ND	R	14 %	357	25	86
76-13-1	Trichlorotrifluoroethane	93 *	R	R	ND	ND	ND	R	R	32	106	ND	ND	ND	R	R	ND	ND	7 %	106	9	26
	Total:		3,622	9,419	2,971	13,150	1,102	5,327	19,032	39	1,922	2,828	20,367	5,130	104,186	3,040	1,172	54	N/AP	N/AP	N/AP	N/AP
	Maximum:		2,467	2,648	2,240	6,744	371	1,924	8,457	32	939	1,384	11,090	3,168	31,215	2,099	634	27	93 %	31,215	3,419	7,606
	Mean:		95	248	78	346	29	140	501	1	51	74	536	135	2,742	80	31	1	18 %	2,947	318	724
	Std. Dev. of Mean:		403	640	374	1,191	83	421	1,716	5	203	252	1,961	589	7,942	340	131	5	26 %	7,892	852	1,927
	No. of Compounds Found:		11	8	2	5	10	11	4	2	3	4	5	2	15	12	2	3	(Total of 23 target VOCs detected)			

NOTE: Data presented in this table are not blank-corrected and therefore represent a conservative estimate of true values (i.e., true values are slightly lower than data presented here).

* HSL compounds Acrolein (#1) and Acrylonitrile (#2) deleted from HSL by USEPA.

Tetrahydrofuran (91*), Trichlorofluoromethane (92*), & Trichlorotrifluoroethane (93*) not on HSL, but reported on lab's list of target compounds.

ND = Not Detected (detection limits vary by compound and as a function of matrix interferences).

R = Rejected data value; QA/QC review indicated sample results not sufficiently higher than lab blank to report value.

ND and R values assumed to have a numerical value equal to zero for purposes of statistical computations.

(data value) E = Estimated data value; estimate based on cryogenic system blank from date other than sample analysis date due to lab's loss of blank data file.

SOURCE: DRAFT MIDWAY LANDFILL REMEDIAL INVESTIGATION GAS CHARACTERIZATION TECHNICAL MEMORANDUM (01/14/88)

Table 6.2 Maximum ambient air concentration of compounds detected at each station by chemical species.

Chemical Species	Sampling Location AQ-1 (ppb)	AQ-2 (ppb)	AQ-3 (ppb)	AQ-4 (ppb)	AQ-6 (ppb)	AQ-7 (ppb)	Max.[1] Observed Conc., All Stations (ppb)	Mean Conc., of All Samples (ppb)	Ambient[2] Air Standard (ppb)	Ratio Max. Obs. Conc./ Standard (unitless)	Ratio Mean Obs. Conc./ Standard (unitless)
Trichlorofluoromethane	0.90	0.80	0.70	0.60	0.40	0.90	0.90	0.32	<100.00>	0.009	0.003
Methylene Chloride	0.05	0.40	0.50	0.50	0.30	45.20	45.20	0.82	10.20	4.431	0.080
Chloroform	0.03	0.09	0.08	0.30	0.05	0.08	0.30	0.02	136.00	0.002	0.000
1,1,1-Trichloroethane	0.20	0.40	0.90	0.50	0.20	0.30	0.90	0.16	95.20	0.009	0.002
Carbon tetrachloride	0.05	0.10	0.10	0.10	0.04	0.10	0.10	0.02	6.80	0.015	0.003
Benzene	0.50	3.10	5.40	22.90	1.10	4.80	22.90	1.24	13.60	1.684	0.091
Trichloroethene	0.00	0.01	0.30	0.003	0.00	0.00	0.30	0.01	34.00	0.009	0.000
Toluene	0.70	2.90	7.60	6.80	0.90	2.60	7.60	1.23	136.00	0.056	0.009
Tetrachloroethene	0.00	0.30	1.20	1.60	1.20	2.70	2.70	0.20	13.60	0.199	0.015
Chlorobenzene	0.00	0.00	0.00	0.05	0.00	0.00	0.05	0.001	20.40	0.002	0.000
Ethyl Benzene	0.20	0.30	0.90	0.50	0.00	0.10	0.90	0.07	13.60	0.066	0.005
M,P-Xylene	0.20	1.60	3.60	1.70	1.40	1.20	3.60	0.56	13.60	0.265	0.041
O-Xylene	0.07	0.60	1.40	0.50	0.50	0.50	1.40	0.17	13.60	0.103	0.013
P-Dichlorobenzene	0.00	0.00	0.07	0.09	0.07	0.06	0.09	0.01	10.20	0.009	0.001
Chloromethane	0.70	0.00	13.20	67.70	23.90	0.90	67.70	2.00	<5.00>	13.540	0.400
Bromomethane	0.00	0.00	0.00	2.20	0.00	0.00	2.20	0.03	6.80	0.324	0.004
Chloroethane	0.00	0.00	0.00	0.00	0.20	0.00	0.20	0.003	136.00	0.001	0.000
Heotane	000	0.60	0.30	0.90	0.00	0.30	0.90	0.05	<8.50>	0.106	0.006
Styrene	0.06	1.50	0.60	0.10	0.400	1.60	1.60	0.11	68.00	0.024	0.002
Acetone	13.20	11.80	10.00	10.60	6.70	13.00	13.20	3.26	3,401.00	0.004	0.001
Z-butanone	0.20	0.30	2.00	0.60	0.30	0.50	2.00	0.14	<20.00>	0.100	0.007
Hexane	0.50	3.30	4.20	3.30	1.00	1.90	4.20	0.68	<5.00>	0.840	0.136

N/AV = Not Available
ppb = parts per billion (volume)

[1]Maximum of all values, including upwind, downwind, and off-site filed samples for each station location.

[2]The Massachusetts Acceptable Ambient Level (MA-AAL) values were used as the primary standard; where they were not available, comparisons are presented between maximum observed concentration and 1/10,000 of the most stringent Occupational Exposure Guideline (from OSHA, NIOSH, or ACGIH guidelines) and indicated by <value>.

TABLE 1

SUMMARY OF GAS FLOW PARAMETERS

	Duct Diameter (Ft.)	Gas Temp. (°F)	Gas Velocity (fps)	Actual Gas Flow Rate (acfm)	Std. Gas Flow Rate (dscfm)	CH_4 (%)	CO_2 (%)	O_2 (%)	H_2O (%)	CO (PPM)
North Flare										
Landfill Gas Inlet	0.67	108	25.64	537	479	32	29.5	3.3	4.0	1
Flare Exhaust	4.0	1560[1]	20.71[2]	15,618[2]	3,746[2]	NM	13	6.5	7.9	NM
South Flare										
Landfill Gas Inlet	0.67	109	36.19	758	677	26	26	3.0	4.0	2
Flare Exhaust	4.0	1625[1]	23.52[2]	17,735[2]	4,239[2]	NM	12	7.1	5.3	NM

1 - Temperature at sampling point in the flame

2 - Flare exhaust flow rates calculated from estimated net heat release

NM - Not Measured

SOURCE: MIDWAY LANDFILL TECHNICAL
DISCIPLINE REPORT -- AIR QUALITY
(SUBMITTED TO PMX, INC. BY
TRC ENVIRONMENTAL CONSULTANTS)
10/23/87 (CURRENTLY UNDERGOING
REVISION BY TRC)

Data for hydrogen sulfide are presented in Table 6.8 (Source: Draft Midway Landfill RI Summary Report; draft dated 01/19/88. Hydrogen cyanide was not detected in onsite gas.

Samples of flare gas near the top of the flame indicated that some compounds are destroyed with greater than 90 percent efficiency; because of some methodological limitations in this part of the study, calculations of the destruction and removal efficiency of the flares are currently being revised.

Migration Pathways and Extent of Migration. The migration pathways for landfill gas escaping to the atmosphere are the possible cracks or fissures in the soil cover and the gas flares venting the gas control wells. The upwind/downwind comparison used in the ambient air quality study was designed to determine whether or not emissions from the landfill surface are contributing significant amounts of contaminants to the ambient air. Maximum and mean ambient air concentrations of compounds detected at each station, with comparisons with selected ambient air standards, are shown in Table 6.2 (Source: Draft Midway Landfill Remedial Investigation Summary Report; draft dated 01/19/88). Results did not support the hypothesis that the landfill is a significant source of contaminant emissions to ambient air.

Flare sampling results were combined with meteorological data to create a computer model for the Midway area of potential worst-case pollution conditions. The pollutant predicted in greatest concentration was benzene (Table 7.9. Source: Draft Midway Landfill Remedial Investigation Summary Report; 01/19/88). Peak 24-hour levels of benzene emitted by the flares and dispersed under local wind conditions, according to the model, were only 10 to 20 percent of U.S. average values for residential areas; annual average concentrations would be only 2 percent of typical U.S. urban values (Figure 7.5. Source: Draft Midway Landfill RI Summary Report; 01/19/88). The study concluded that the concentrations of contaminants of concern estimated to be

Table 6.8. Hydrogen Sulfide Results*

	Average Landfill Gas Inlet (PPMV)	Average Flare Exhaust (PPMV)	Destruction Efficiency (%)
North Flare	26	0	ca. 100
South Flare	17	1	94

PPMV - Parts per million by volume

*Hydrogen results were obtained with a MSA 361 analyzer with a detection limit of 1 ppm.

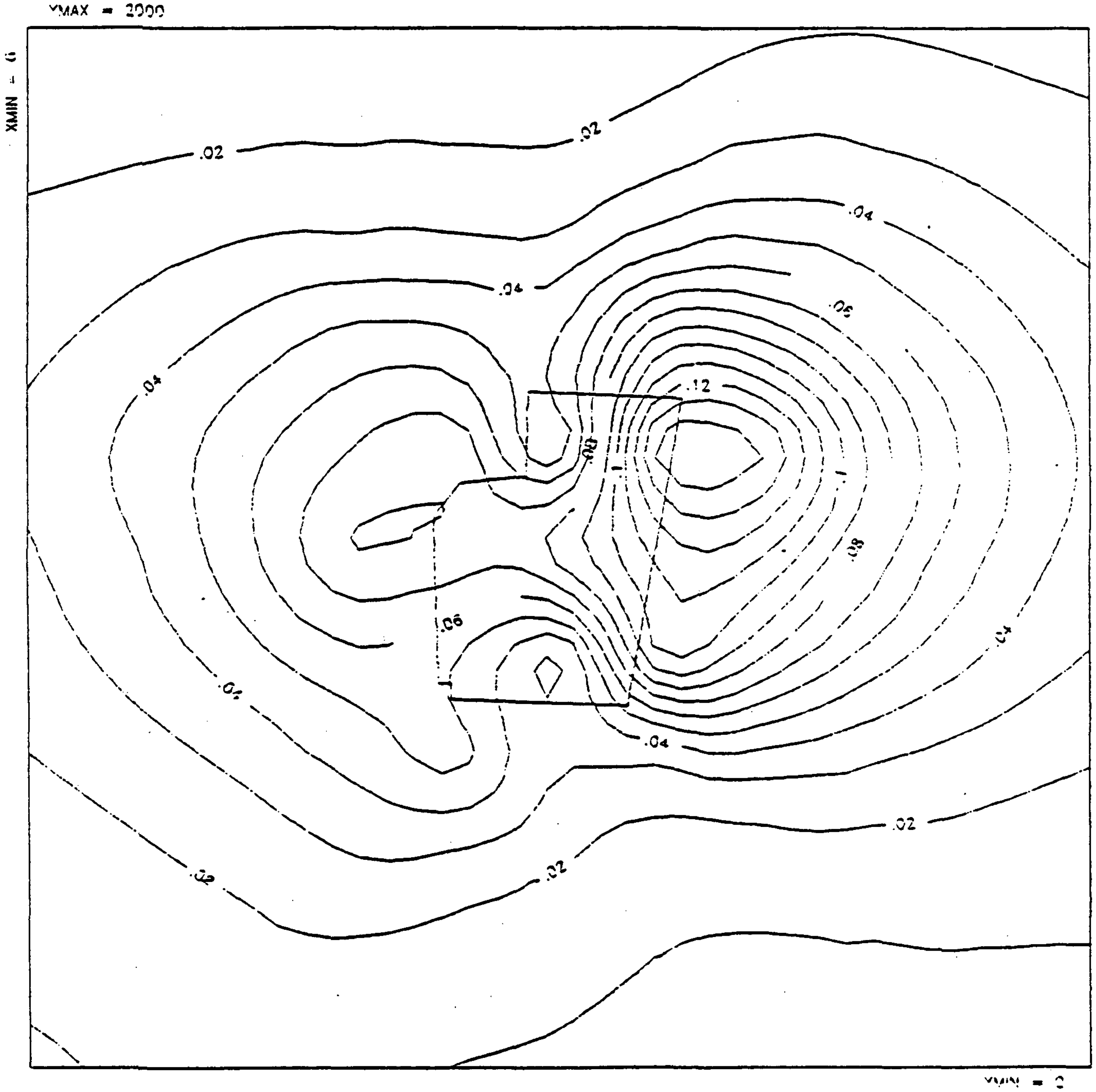


Figure 7.5
Isopleths of Annual-Average Benzene Concentration in ug/m3 Predicted by Air Quality Modeling

SOURCE: DRAFT MIDWAY LANDFILL REMEDIAL INVESTIGATION SUMMARY REPORT (01/19/88)

Table 6.3. Comparison of Midway Concentrations with U.S. Mean Values in ug/m^3.

Species	Midway	U.S. Mean Concentration	Ratio of Midway Value to U.S. Mean (%)
1,1,1-Trichloroethane	0.8	2.8	29
Benzene	3.8	8.9	43
m,p-Xylene	1.9	12.0	16
o-Xylene	0.5	5.2	10
Ethylbenzene	0.2	5.2	4
m,p-Dichlorobenzene	0.05	0.28	18
o-Dichlorobenzene	0.0	0.066	(0)
Chloroform	0.08	0.35	23
Carbon tetrachloride	0.1	1.2	8
			mean = 17%

Source: Wallace et al. (1985)

Table 7.9 Landfill Flare Air Quality Modelling Results

		Total (both flares) Concentrations					
	Per Flare Emissions	(in ug/m3)		(in ppb)		U.S. Average	
Compound	(g/sec)	24-hr	annual	24-hr	annual	(ug/m3)	ppb
Dichlorodifluoromethane	0.001984	0.078	0.010	0.058	0.008		
Vinyl Chloride	0.001575	0.062	0.008	0.091	0.012		
Chloroethane	0.001228	0.048	0.006	0.069	0.009		
Methylene Chloride	0.000031	0.001	0.000	0.001	0.000		
Trichlorofluoromethane	0.000220	0.009	0.001	0.008	0.001		
1,1-Dichloroethane	0.000094	0.004	0.000	0.003	0.000		
1,2-Dichloroethane	0.000630	0.025	0.003	0.023	0.003		
Trichloroethene	0.000031	0.001	0.000	0.001	0.000		
Benzene	0.029578	1.158	0.155	1.374	0.184	8.900	2.786
Toluene	0.011403	0.446	0.060	0.449	0.060		
Ethyl Benzene	0.008221	0.322	0.043	0.281	0.038	0.200	0.046
Tetrachloroethane	0.000094	0.004	0.000	0.002	0.000		
Chlorobenzene	0.002583	0.101	0.014	0.083	0.011		

emitted by the Midway Landfill flares would be a small fraction of ambient air concentrations of those contaminants in typical U.S. urban areas.

Potential Receptors. Potential receptors of landfill emissions into ambient air are the human and wildlife populations in the surrounding neighborhoods. Under the remediated conditions studied, the evidence suggests that these receptors are not at risk.

3.1.4 Subsurface Landfill Gas Studies

Data Obtained and Methods Used. Approximately 150 offsite gas monitoring probes, 19 offsite gas control wells, and 70 onsite migration control wells were installed by the City of Seattle and the Washington Department of Ecology to monitor and control the offsite migration of gas from the Midway Landfill. These probes and wells are routinely monitored as a necessary part of operation of the gas control system. In addition, 10 multi-completion offsite monitoring probes were installed specifically for the remedial investigation to supplement the existing data base. Up to 4 screened intervals were installed in each probe to enable sampling from the lithologic layers that are potential gas transmitters. Measurements routinely taken at offsite monitoring probes and offsite control wells include:

- o Combustible gas (percent, parts per million, or percent LEL)
- o Oxygen (percent)
- o Static pressure (vacuum in the well)
- o Velocity (control wells only)

Periodic measurements are taken in the control wells for:

- o Carbon dioxide (percent)
- o Hydrogen sulfide (parts per million)

The onsite gas migration control wells are measured weekly for:

- o Combustible gas percentage
- o Oxygen percentage
- o Carbon dioxide percentage
- o Static pressure
- o Temperature
- o Velocity of gas stream in well

Nature of Contamination. The primary consideration in controlling the offsite migration of subsurface gas is the methane content. Although methane is odorless and non-toxic, it is highly flammable and may explode if combined with air in an enclosed space, even at relatively low concentrations. The lower explosive limit (LEL) for methane is approximately 4.8 to 5 percent and the upper explosive limit (UEL) approximately 15 percent methane by volume in air.

Migration Pathways, Extent of Migration. Combustible gas can migrate through subsurface strata that are gravelly or porous; water-bearing strata that have become dry can become pathways for gas migration. Electrical conduits, storm drains, sewage pipes, gravel pipe bedding, or other man-made conduits also may permit the movement of subsurface gas.

At the initiation of the emergency remedial action, combustible gas had been found in the basements of structures up to 1000 feet from the landfill. Large reservoirs of gas were known to exist to the east, southeast, and south of the landfill.

Results of the monitoring program and other studies reported here indicate that the onsite migration control wells and offsite extraction wells have significantly reduced offsite migration of gas from the Midway Landfill. In general, when offsite control wells were installed near structures where high levels of gas had been detected, the gas was effectively removed from the structure within one day of startup. Furthermore, gas has remained out of structures in the vicinity of the landfill since the implementation of the offsite control wells. Combustible gas concentrations above 100 parts per million have not been recorded in a structure in the vicinity since November, 1986.

The larger offsite control wells have also been successful in reducing the concentrations of methane gas that had migrated from the landfill to form large reservoirs offsite. As a result, many offsite control wells have been shut down after extremely low methane concentrations were recorded in nearby monitoring probes over a period of several months. Because of the influence of the onsite migration control system, it is not expected that landfill gas will return to these areas. However, the probes will continue to be monitored and the control wells will be restarted if any significant rise in methane levels is detected.

Landfill gas detected offsite at shallow depths has been reduced greatly, from as high as 55% by volume in some areas to less than 5% by volume in all areas. Deep gas concentrations offsite also have been reduced from as high as 70% by volume in some areas down to less than 5% by volume west of the landfill and less than 40% by volume in areas north, northeast and southeast of the landfill. Most areas of deep gas still occuring off-site currently show concentrations of less than 20 percent by volume.

<u>Potential Receptors</u>. Potential receptors of subsurface landfill gas that has migrated offsite include persons within the structures in the vicinity of the landfill. The effectiveness and continued operation of the gas control system should prevent further problems of this nature offsite.

3.2 CONCLUSIONS

Studies show little or no evidence that hazardous substances have migrated from the landfill to the surrounding environment since the implementation of the ERAs. The ERAs appear to have been effective in controlling gas migration and airborne contaminants. Surface water does not exit the landfill, and surface water in areas surrounding the landfill is not contaminated. Current evidence strongly indicates that a contaminant plume in groundwater to the south of the landfill does not originate in the landfill (i.e., it appears to have an offsite source). The landfill does not contribute hazardous contaminants to the environment at greater levels than are normally found in urban areas. Therefore, the evidence available from the remedial investigation indicates that potential receptors are not at risk.

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